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Effects of organic manures and inorganic fertilizers on growth and yield of wheat (*Triticum aestivum* L.)

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Abstract
The present study was conducted on loam soil at Agronomy Farm, Mewar University, Gangrar, during the *rabi* season of 2021-22. Ten treatments consisting of Control, 100% recommended dose of nitrogen (RDN) + 25% N through FYM, 100% T3-100% RDN + 25% N through vermicompost, 75% RDN + 25% N through FYM, 75% RDN + 25% N through vermicompost, 50% RDN + 50% N through FYM, 50% RDN + 50% N through vermicompost 50% RDN + 50% N through vermicompost, 25% RDN + 75% N through FYM, 25% RDN + 75% N through vermicompost and 100% RDN through chemical fertilizer in Randomize Block Design with three replications. The wheat cultivar of Raj-3077 was grown in the experiment.
The highest yield attribute and yield were recorded with 100% RDN + 25% N through vermicompost through compost which was statistically similar to the treatment of 100% recommended dose of nitrogen (RDN) + 25% N through FYM and significantly higher than the 100% RDN through chemical fertilizer and control. Among the different combinations of organic manures with compost of nutrients, the replacement of 100% RDN through chemical fertilizer recorded significantly higher yield attributes and yield along with higher net return and B: C ratio. The treatments with compost of nutrients recorded higher nutrient content and nutrient uptake over 100% RDN + 25% N through vermicompost with inorganic fertilizer. On the basis present study, it may be conducted that the integrated use of the organic source of nutrients can enhance the productivity of the wheat system.

Keywords: Vermicompost, ten treatments consisting, agronomy farm

Introduction

Wheat (*Triticum aestivum* L.) is *a* very important staple and remunerative *rabi* crop, cultivated in almost all the countries of the world. Among major wheat-producing countries, India ranked second next to China concerning its production in the world (Agriculture Sectors National Portal). It is the second most important cereal crop after rice in India and is grown under diverse agro-climatic conditions.

India has the largest area under wheat (29.14 million hectares) but ranks second in production (102.19 million tonnes) after China with average productivity of 3154 kg/ha. It is cultivated mainly in the states of Uttar Pradesh, Madhya Pradesh, Punjab, Rajasthan, Haryana, Bihar, Gujarat, and Maharashtra. Among the different states of India, Uttar Pradesh ranks first in both area and production, while Punjab ranks first in productivity. In Rajasthan, the crop occupies an area of 3.4 million hectares and production of 13.88 million tonnes with average productivity of 3355 kg/ha. The average productivity of wheat in the state is far behind the attainable productivity of this crop mainly because of inadequate and imbalanced use of plant nutrients.

Wheat (*Triticum aestivum* L.) is one of the important grain crops produced worldwide and is a staple food for about one-third of the world's population. Wheat flour has many uses, but its main use is to make bread, a staple food for many people around the world (Hussain and Shah, 2002) [35].

The productivity of wheat in Rajasthan is low as compared to Punjab and Haryana mainly due to arid and semi-arid climates. Sandy soils are of wide occurrence in Rajasthan. These soils are excessively permeable mainly because of their coarse texture and poor organic matter content.

The moisture retention capacity of these soils is also very low and more than one-third of applied water or through rains get lost through deep percolation (Mann and Singh 1975) [113]. Wheat is an exhaustive crop of soil nutrients.

Soil organic matter plays a key role in influencing the nutrient dynamics in soils. It acts as a sink by hoarding the nutrients temporarily through an array of biochemical processes ranging from adsorption reactions to organic-nutrient forms. Organically held plant nutrients play a vital role in sustaining plant nutrient availability. It also maintains optimum temperature and moisture in the soil.

Vermicompost, is nowadays gaining more and more importance as a substitute for other organic manures due to its comparatively higher nutrient concentration with a quick release of nutrients and which are available mostly to the current crop. It also takes part in improving the physical conditions of the soil. Vermicompost is an eco-friendly and effective way to recycle agriculture and kitchen waste. It can also be called biological manure and its application not only adds plant nutrients (macro and micro) and growth regulators but also increases soil water retention, nutrient content and organic carbon content of the soil. Sequences rice-rice-sesame (*Sesamum indicum*) and rice-rice-okra (*Abelmoschus esculentus*) reduced the available nitrogen status of the soil. Integration of nutrient sources made the predominant rice-rice-sesame cropping sequence more productive in the sandy-loam soil. Inclusion of groundnut and cowpea in rice-based crop sequences increased the yield of the Rajput (2008) [79] studied the effect of nutrient management practices on the growth and yield of pearlmillet (*P. glaucum* cv.) Pusa 605). The highest yield was obtained with 5 t farmyard manure/ha. Each unit increase in N level (0, 30 and 60 kg/ha) enhanced the growth, yield components (Plant population, plant height and test weight) and yield of peal millet. The highest grain yield (24 q/ha) was obtained with the highest N level.

Ram Lal *et al.* (2008) [80] found that application of 75% RDF NPK fertilizers + 5 tonnes vermicompost-mustard straw/ha gave significantly higher grain and straw yield 48.09 and 74.59 q/ha respectively as compared to the recommended rate of NPK (80:48:0) and it was at par with 100% recommended rate of NPK + 10 tonnes FYM/ha and 50% recommended rate of NPK + 7.5 tonnes vermicompost-mustard straw/ha.

Ashoka *et al.* (2009) [4] reported that application of RDF + 25 kg $ZnSO_4$ /ha + vermicompost @ 3.5 t ha^{-1} recorded significantly higher growth parameters and quality parameters *viz.*, protein (cereals).

Materials and Methods

A field study on the topic "Effect of organic manures and Inorganic Fertilizers on growth and yield of wheat (*Triticum aestivum* L.)" was conducted during the *rabi* season of 2021-22 at the Agronomy Farm, Mewar University, Gangrar. The details of experimental techniques adopted, criteria used for treatment evaluation and methods followed during the entire course of investigation are presented in this chapter.

Location of experimental site

Chittorgarh is located at 24.88°N 74.63°E. It has an average elevation of 394 meters (1292 ft). Chittorgarh is located in the southern part of the state of Rajasthan, in the northwestern part of India. It is located beside a high hill near the Gambheri River. Chittorgarh is located between 23° 32' and 25° 13' north latitudes and between 74° 12' and 75° 49' east longitudes in the southeastern part of Rajasthan state.

Climate and Weather conditions

The climate of this region is typically semi-arid, with extremes of temperatures during both seasons. During summers, the temperature may go as high as 48 °C while in winter, it may fall as low as -1.0 °C. The mean rainfall of the tract is about 450 mm most of which is contributed by the South-West monsoon from July to September. Since, climate influences the growth, yield, and quality of agricultural produce, therefore climatic variables are presented in this chapter. The mean weekly values of important climatic parameters *viz.*, maximum and minimum temperatures, rainfall, relative humidity, sunshine hours, evaporation, etc. recorded at the college meteorological observatory during the crop season are presented in table.

Meteorological observations

The weather conditions that prevailed during the period of experimentation (November 2021 to April 2022) were recorded at the meteorological observatory of the college farm and have been given in Table 3.1 and graphically depicted in Fig. 3.1.

Table 1: Mean weekly weather parameters for crop season (*rabi*, 2021-22)

SMW* No.	Temp. °C		Relative humidity %	Evaporation (mm/day)	Total rainfall (mm)	Sunshine hrs/day
	Max	Min				
47.	23.1	12.5	77	1.5	018.4	4.3
48.	23.0	8.1	63	2.0	000.0	7.6
49.	23.0	6.1	57	2.1	000.0	8.5
50.	23.3	3.4	55	2.1	000.0	8.0
51.	24.7	2.0	59	2.3	000.2	8.6
52.	22.5	7.8	65	2.3	000.0	6.9
1.	17.8	7.4	71	1.5	000.0	6.4
2.	22.5	3.7	59	2.3	000.0	9.1
3.	21.5	1.6	61	1.9	000.0	9.3
4.	22.5	4.5	57	2.4	000.0	8.6
5.	23.5	4.3	57	2.4	000.0	9.0
6.	26.7	7.0	56	2.9	000.8	9.5
7.	24.0	09.1	67	2.6	032.8	7.2
8.	23.5	09.1	66	2.9	000.0	8.1
9.	25.3	11.0	61	2.9	001.0	7.2
10.	28.1	10.6	53	2.7	000.0	8.7
11.	33.0	09.5	49	4.1	000.0	9.4
12.	34.8	12.6	41	4.0	000.0	8.7
13.	36.2	15.7	39	6.0	000.0	8.8
14.	34.5	13.5	36	7.0	000.0	8.7
15.	35.1	17.8	34	4.4	000.0	6.8
16.	35.9	17.6	34	5.2	000.4	9.1

SMW = Standard meteorological week.

Experimental details

Treatments

S. No.	Treatments	Symbols
1.	Control	T1
2.	100% recommended dose of nitrogen (RDN) + 25% N through FYM	T2
3.	100% T3-100% RDN + 25% N through vermicompost	T3
4.	75% RDN + 25% N through FYM	T4
5.	75% RDN + 25% N through vermicompost	T5
6.	50% RDN + 50% N through FYM	T6
7.	50% RDN + 50% N through vermicompost	T7
8.	25% RDN + 75% N through FYM	T8
9.	25% RDN + 75% N through vermicompost	T9
10.	100% RDN through chemical fertilizer	T10

Table 2: Effect of organic manures and inorganic fertilizers on plant height of wheat crop

Treatment	Plant height(cm)			
	30 DAS	60 DAS	90 DAS	At harvest
T_1 Control	38.3	86.6	89.3	93.0
T_2 100% recommended dose of nitrogen (RDN) + 25% N through FYM	49.3	98.0	107.0	111.0
T_3 100% RDN + 25% N through vermicompost	51.0	111.3	115.0	119.0
T_4 75% RDN + 25% N through FYM	47.0	104.0	110.6	112.3
T_5 75% RDN + 25% N through vermicompost	45.2	99.0	108.3	111.0
T_6 50% RDN + 50% N through FYM	47.3	98.6	111.0	115.0
T_7 50% RDN + 50% N through vermicompost	46.6	102.0	110.0	116.3
T_8 25% RDN + 75% N through FYM	47.3	101.0	110.0	114.6
T_9 25% RDN + 75% N through vermicompost	45.6	98.0	108.0	115.0
T_{10}100% RDN through chemical fertilizer	47.6	103.3	106.0	109.0
S.Em ±	2.0	2.1	2.2	2.0
CD (P=0.05)	5.9	6.3	6.5	6.0

RDN: Recommended Dose of Nitrogen, VC: Vermicompost, FYM: Farm Yard Manure.

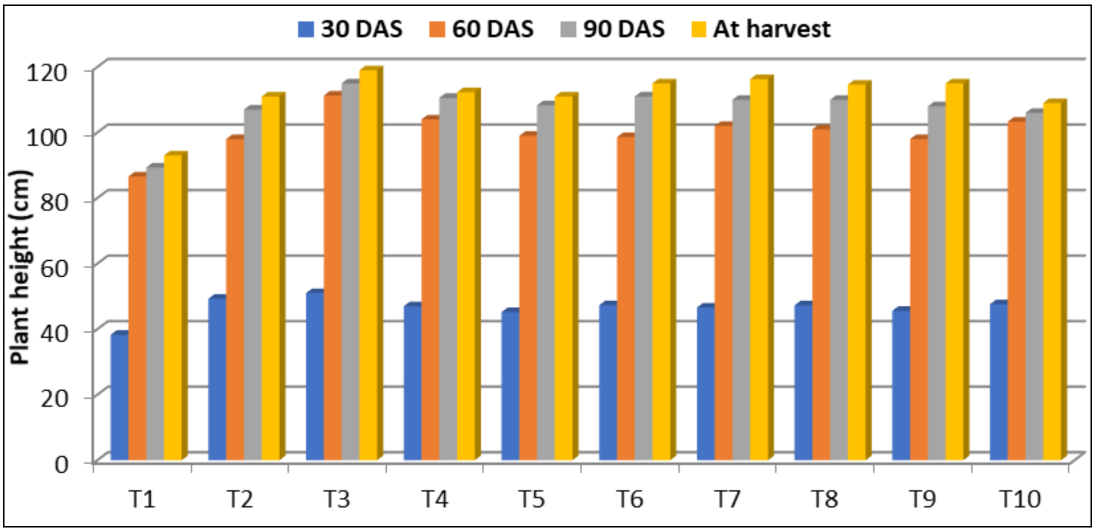

Fig 1: Effect of organic manures and inorganic fertilizers on plant height of wheat crop

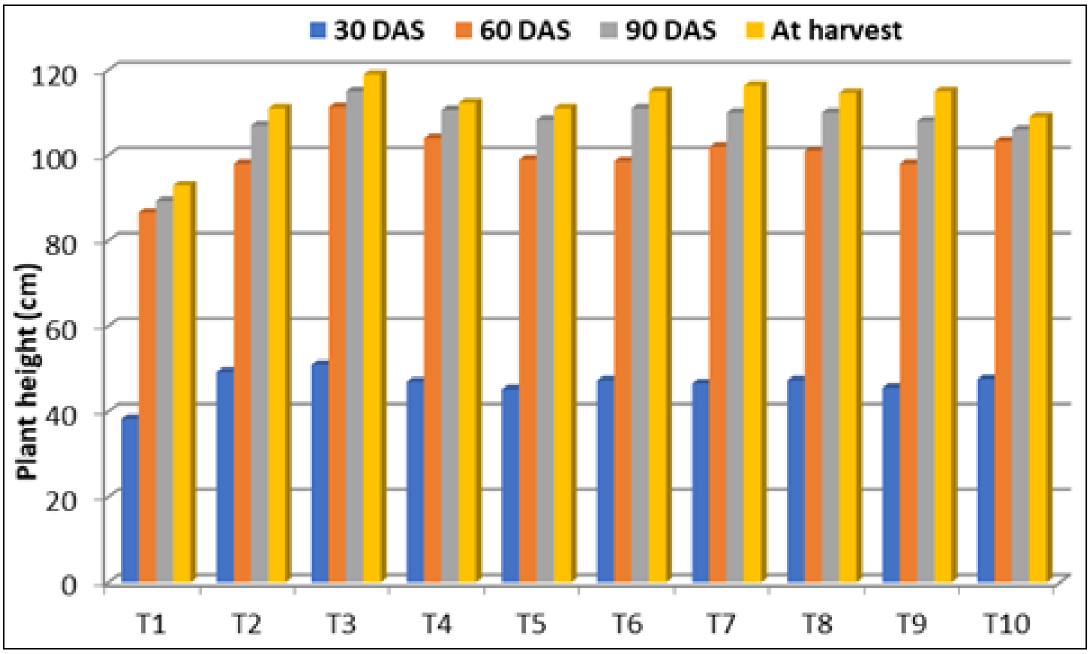

Fig 1: Effect of organic manures and inorganic fertilizers on plant height of wheat crop

Table 3: Effect of organic manures an Inorganic Fertilizers on dry matter accumulation (g m^{-2}) of wheat at different stages

Treatments	Dry matter accumulation (g m^{-2})			
	30 DAS	60 DAS	90 DAS	At harvest
T_1: Control.	115	356	511	644
T_2: 100% recommended dose of nitrogen (RDN) + 25% N through FYM.	148	459	747	972
T_3: 100% RDN + 25% N through vermicompost.	167	535	895	1085
T_4: 75% RDN + 25% N through FYM.	160	487	887	1034
T_5: 75% RDN + 25% N through vermicompost.	149	462	871	1026
T_6: 50% RDN + 50% N through FYM.	164	499	881	1035
T_7: 50% RDN + 50% N through vermicompost.	152	471	867	1014
T_8: 25% RDN + 75% N through FYM.	161	496	874	1014
T_9: 25% RDN + 75% N through vermicompost.	157	477	873	1022
T_{10}: 100% RDN through chemical fertilizer.	150	466	866	1014
S.Em ±	0.5	0.5	6.5	8.1
CD (P=0.05)	1.6	1.7	19.7	24.3

RDN: Recommended Dose of Nitrogen, VC: Vermicompost and FYM: Farm Yard Manure

Table 4: Effect of organic manures and Inorganic Fertilizers on grain, straw, biological yield (q ha^{-1}) and Harvest Index (%)

Treatment	Yield (q ha^{-1})			Harvest index (%)
	Grain	Straw	Biological	
T_1: Control	24.45	40.54	64.99	37.62
T_2: 100% recommended dose of nitrogen (RDN) + 25% N through FYM	38.84	59.48	98.32	39.50
T_3: 100% RDN + 25% N through vermicompost	45.66	64.98	110.64	41.27
T_4: 75% RDN + 25% N through FYM	41.75	63.43	105.18	39.69
T_5: 75% RDN + 25% N through vermicompost	41.05	63.19	104.24	39.38
T_6: 50% RDN + 50% N through FYM	42.83	62.32	105.15	40.73
T_7: 50% RDN + 50% N through vermicompost	41.45	61.45	102.90	40.28
T_8: 25% RDN + 75% N through FYM	42.32	61.89	104.21	40.61
T_9: 25% RDN + 75% N through vermicompost	41.55	63.58	105.13	39.52
T_{10}: 100% RDN through chemical fertilizer	41.23	62.34	103.57	39.81
SEm ±	1.33	1.87	2.58	0.39
CD (P=0.05)	3.89	5.60	7.74	1.19

RDN: Recommended Dose of Nitrogen, VC: Vermicompost and FYM: Farm Yard Manure

Results

The salient findings of the experiment entitles "Effect of Organic Manures and Compost on Growth and Yield of Wheat (*Triticum aestivum* L.)" have been presented in the preceding chapter with a detailed account of the performance of wheat in terms of crop growth and development, yield and yield attributes, uptakes of nutrients by crop and its economics influenced by different treatments. Several points of interest have emerged which are being discussed here with the support of findings of other workers.

Attempts have also been made here to evaluate and explain the important observations recorded and results obtained in the course of present investigation concerning cause and effect relationship as for as possible.

Effect of organic and inorganic source of nutrients in integrated mode in present investigation, the organic and inorganic source of nutrients in integrated mode envisaged pronounced variation in growth character of wheat. Same pronounced variation were noted with different source of nutrients in yield and attributes factors. Thus, application of inorganic and organic fertilizer in integrated mode proved import for growing wheat, successfully under agro-climatic conditions of Meerut. One of the main functions of organic nutrient is the initiation of meristmatic activity of the plants. The cell division and cell enlargement are also accelerated by ample supply of nutrient by organic source.

Growth characters

The crop growth expressed in terms of plant height, number of tillers, dry matter of crop increased significantly due to different organic, compost of fertilizer and their combinations. At maturity stage the organic and fertilizer treatment *i.e.* 100% RDN + 25% N through vermicompost produced the tallest plant. Similar reports were also observed earlier by Gupta (1998) [114] and Kumar (2001) [115].

An examination of tillering is one of the useful ways to determine the growth status of wheat plant. Under nutrient shortage conditions when tillering is retarded, the growth parameter such as dry weight also decreased (Yoshida, 1981) [116]. In present study, all the organic, fertilizer treatments had significant bearing on the number of tillers m^{-2}. The number of tillers m^{-2} at different stage was recorded higher at all the stage of crop growth which was significantly higher than other treatments. The number of tillers m^{-2} decreased in all the treatments at harvest due to shoot maturity.

Nayak and Murty (1980) [117] also observed low tillering due to low light intensity during the monsoon. Venkteswarlu and Visperas (1987) [118] stated that the capacity of tillering and panicle number is a function of the environment, dominated by light within a range of 37.0 °C mean Maximum temperature.

With the advancement of the age of wheat crop, there was successive increases in the number of tillers m-2 (Table 4.3) introspective of rate of fertilizer application in different mode. The number of tillers m-2 responded to organic fertilizer at all the periodical stage.

The first prerequisite for yields is a higher production of total dry produced depends on photosynthesis which in turn depends upon large and efficient assimilating area, adequate supply of solar radiation, carbon dioxide and favourable environment conditions. In present context, the various organic and nitrogen fertilizer treatment exhibited significant influence on the dry matter accumulation at maximum tillering stage (Table 4.3). The treatment including 100% RDN + 25% N through vermicompost and use of organic source of nutrient produced significantly higher dry matter than the common practice of applying fertilizer nitrogen.

The amount of economic yield also depends upon the manner in which the net dry matter produced is distributed amount the different parts of the plant. This explains as to how higher grain yields were obtained with 100% RDN + 25% N through vermicompost treatment or in the treatments where organic source of nutrient were used.

Yield attributes

Spike length is most important yield attributing character. The various organic, nitrogen and fertilizer treatments had a significant bearing on the number of spike. The treatment 100% RDN + 25% N through vermicompost and (75% RDN + 25% N through FYM) produced a significantly higher number of spike than all other treatments. Greater survival of tillers under these treatments could be due to continuous but controlled supply of nutrients particularly N, commensurate with the requirement at different growth stages. Yoshida (1981) [116] explained the fate of tillers during tillering which intern decided the spike numbers. He noticed that the tillering depends upon nutritional status of plant, supply of carbohydrates, light and temperature conditions.

Grain yield is the manifestation of yield attributing characters significantly higher values of yield attributes such as test weight, number of grain per spike and number of spike per plant were noticed under the treatment with organic combination as well as 100% & 100% RDN + 25% N through vermicompost. Singh *et al.* (2001) [97] reported that yield increase under FYM applied treatment the capacity of wheat plant to extract nutrient from the deeper soil layers. More ever, these organic manures might have helped in improving the nutrient availability from the soil for a prolonged period on one hand and mitigating the deficiency of different nutrient as well as improving the soil physical condition on the other which ultimately increase the crop yield (Naphade *et al.*, 1993) [68].

Difference in 1000 grain weight (g) due to different organic and nitrogen fertilizer treatments were found significant may be due to variations in source of nutrients. Grain weight increased significantly with the application of nutrient fertilizer along with FYM and vermicompost. The application of 100% RDN + 25% N through vermicompost resulted in higher value of yield attributes. This might be due to the application of organic and nitrogen fertilizer increased the growth attributes that provide more photosynthetic surface resulted in the synthesis of more food materials, consequently better development of yield attitudes.

The results of present investigation in respect of these yield attributes are in agreement with the finding of Shivery and Singh (2003); Pariyani and Naik (2004) [72]; Kumar *et at.* (2005) [50]; Singh *et al.* (2005) [94] who reported the response of wheat crop to nitrogen in the yield attributes.

The ultimate aim of agronomical investigation is to enhance the productivity of crop by manipulating the growth characters as well as yield attributes in favour of crop yield (grain). The wheat produced the lowest grain (24.45q ha^{-1}) and straw (40.54 q ha^{-1}) yield under control plots. The maximum grain (45.66 q ha^{-1}) and straw (64.98 q ha^{-1}) yield observed with the application of 100% RDN + 25% N through vermicompost grain yield is function of yield attributes *viz.* number of tillers, number of grain per spike and test weight to crop gave the higher values of yield attributes and resulted in higher yields. The increase in yield of wheat was probably due to the fact that application of improves the physiochemical conditions of soil and better supply of nutrients to crop and ultimately resulted in higher yields. These findings are in conformity with the finding of Pariyani and Naik (2004) [72]; Kumar *et al.* (2005) [50]; Singh *et al.* (2005) [94].

The different treatments consisting of organic and fertilizer combinations were found to increase N content in grain and straw over unfertilized Control. Both purely organic N and inorganic fertilizer treatments (100% RDN + 25% N through vermicompost) had significantly higher N content in grain and straw (1.295 and 0.637 g) than the other treatments. The increase in N content of grain and straw of wheat inorganic N fertilized treatment might be attributed to the slow and continuous supply of N throughout the crop growth by these organic manures.

Nutrient uptake is determined by biological yield and concentration of nutrients in plants. The significant difference in N uptake by grain and straw due to various nutrient sources associated mainly with the yield difference and partly with the N uptake in grain and straw. Total nutrient uptake by the wheat crop with integrated use of 75% RDN + 25% N through FYM was significantly higher (93.66 kg N, 27.19 P and 112.50 K ha^{-1}) over control.

This treatment removed significantly higher amount of N than the other treatments. Higher N uptake might be associated with the increased available N pool in soil resulting from conversion of organically bound N to inorganic form by the micro organic (Bellaki and Badanne, 1997) [10] that increased nutrient availability and uptake of N by wheat crop.

Economics

Agronomical studies must have practical value so as to make them affordable to farmers. Hence, analysis of economic factors like cost of cultivation, gross income, net profit and benefit cost ratio are important to evaluate the effect of the treatments from practical point of view to the farming community as well as to the planners. In general, the farmers are mainly interested to earn more profit unit-1 area, time and investment;

Whereas planner's policies are mainly concentrated for high productivity from the crops. Henceforth, economic analyses of the treatments gave fruitful information to both growers as well as planners. The economic analyses are discussed here by considering cost of inputs used and the value of the produce obtained as per prevailing rates in the locality on ha^{-1} area basis.

Among the various treatments with organic combinations, the minimum cost of cultivation (31208 Rs.ha^{-1}) was incurred in 50% RDN + 50% N through vermicompost treatment. Whereas, the maximum cost of cultivation (37568 Rs.ha^{-1}) was 75% RDN + 25% N through FYM treatment due to the higher cost of vermicompost. Gross return is directly related to the value of produce in the market. Among the different combinations of fertilizers and organic manures, the highest gross return of 165832 Rs. ha^{-1}, net return of 134624 Rs. ha^{-1} and B: C ratio of 4.3 was recorded in 75% RDN + 25% N through FYM treatment. B: C ratio is the actual indicator of profit in relation to rupees invested on crop production. Kewat *et al*. (2002) [45] also reported similar results.

References

1. Abdel-Ati AA, Zaki KI. Productivity of some wheat cultivars in calcareous soils under organic farming and rainfed conditions with special references to plant disease. Journal of Agricultural Sciences. Mansoura University. 2006;31(4):1875-1889.
2. Anonymous. Agricultural Statistics at a Glance. Ministry of Agric., Govt. of India, New Delhi; c2021.

3. Arnon DI. Copper enzymes in isolated chloroplasts I Polyphenol oxidase in Beta Vulgaris. Plant Physiology. 1949;24(1):1-15.
4. Ashoka P, Anand SR, Mudalagiriyappa, Smitha R. Effect of macro and micronutrients with organics on growth, quality, yield and economics of Baby corn (*Zea mays* L.) in Tungabhadra Command Area. Crop Research, Hisar. 2009;37(1-3):15-18.
5. Bajpai RK, Chitale S, Upadhyay SK, Urleurkar JS. Long term studies on soil physico-chemical properties and productivity of rice-wheat system as influenced by integrated nutrient management in inception of Chhattisgarh. Journal of the Indian Society of Soil Science. 2006;54(1):24-29.
6. Barik AK, Arindam Das Giri AK, Chattopadhyay GN. Effect of organic (Vermicompost, farm yard manure) and chemical sources of plant nutrients on productivity and soil fertility of *kharif* rice (*Oryza sativa* L.). Crop Research (Hisar). 2006;31(3):339-342.
7. Bathar VM, Patel PT. Effect of zinc, fertility levels and FYM on growth and yield of wheat varieties under North Gujrat Agro-Climatic conditions. GAU Research Journal. 2005;30:32-35.
8. Bathar VM, Patel PT. Effect of zinc, fertility levels and FYM on growth and yield of wheat varieties under North Gujarat Agro-Climatic conditions. GAU Research Journal. 2005;30:32-35.
9. Behera Ashwani Kumar. Response of wheat (*Triticum aestivum*) varieties to sowing date. Indian Journal of Agronomy. 1994;39(1):171-173.
10. Bellaki MA, Badnur VP. Long term effect of integrated nutrients management on properties of vertisol under dry land agriculture. Journal of the Indian Society of Soil Science. 1997;45(3):438-442.
11. Bhakar JR, Sharma OP, Jat BC. Effect of nitrogen and FYM on yield and yield attribues of barley in loamy sand soil. Annals of Agriculture Research. 1997;18:244-245.
12. Bhatia KS, Shukla KK. Effect of continuous application of fertilizer and manures on some physical properties of an eroded soil. Journal of the Indian Society of Soil Science. 1982;30(1):30-36.
13. Biswas CR, Bhattacharya B. Optimizations of nitrogen supply and plant density for a high yielding rice in coastal saline soil. Oryza. 1987;24(3):231-235.
14. Channabasana Gowda, Patil NKB, Patil BN, Awaknavar JS, Ninganur BT, Hunje R. Effect of organic manures on growth, seed yield and quality of wheat. Karnataka Journal of Agricultural Sciences. 2008;21(3):366-368.
15. Chauhan RP. Integrated use of nitrogen source in wheat grown in partially reclaimed sodic soil. Annals of Plant Soil Research. 2001;3:17-25.
16. Chen S, Xu C, Yan J, Zhang X, Zhang X, Wang D. The influence of the type of crop residue on soil organic carbon fractions: An 11-year field study of rice-based cropping systems in southeast China. Agriculture, Ecosystems and Environment. 2016;223:261-269.
17. Chen S, Xu C, Yan J, Zhang X, Zhang X, Wang D. The influence of the type of crop residue on soil organic carbon fractions: An 11-year field study of rice-based cropping systems in southeast China. Agriculture, Ecosystems and Environment. 2016;223:261-269.
18. Choudhary AK, Thakur RC, Naveen Kumar. Effect of integrated nutrient management on soil physical and hydraulic properties in rice-wheat crop sequence in N-W Himalayas. Indian Journal of Soil Conservation. 2008;36(2):97-104.
19. Choudhary CG, Patil MD, Dongale JH. Yield and nutrient uptake of wheat as affected by application of organic matter and slowly available phosphatic fertilizers. Indian Journal of Agricultural Chemistry. 1983;16:275-278.
20. Choudhary M, Rana KS, Rana DS, Bana RS. Tillage and crop residue effects in rainfed pearl millet (*Pennisetum glaucum*) in conjunction with sulphur fertilization under pearlmillet Indian mustard (*Brassica juncea*) cropping system. Indian Journal of Agronomy. 2016;61(1):15-19.
21. Choudhary M, Rana KS, Rana DS, Bana RS. Tillage and crop residue effects in rainfed pearl millet (*Pennisetum glaucum*) in conjunction with sulphur fertilization under pearlmillet Indian mustard (*Brassica juncea*) cropping system. Indian Journal of Agronomy. 2016;61(1):15-19.
22. DAC. Fourth Advance Production Estimates of Majors Crops During; c2018-19.
23. Devi KN, Singh MS, Singh NG, Athokpam HS. Effect of integrated nutrient management on growth and yield of wheat (*Triticum aestivum* L.). J of Crop and Weed. 2011;7(2):23-27.
24. Dhar D, Datta A, Basak N, Paul N, Badole S, Thomas T. Residual effect of crop residues on growth, yield attributes and soil properties of wheat under rice-wheat cropping system. Indian Journal of Agricultural Research. 2014;48(5):373-378.
25. Dotaniya ML. Impact of crop residue management practices on yield and nutrient uptake in rice-wheat system. Current Advances in Agricultural Sciences. 2013;5(2):269-271.
26. Dotaniya ML. Impact of crop residue management practices on yield and nutrient uptake in rice-wheat system. Current Advances in Agricultural Sciences. 2013;5:269-271.
27. Duduat MS, Malavia DD, Mathukia RK, Khanpara VD. Effect of nutrient management through organic and inorganic sources on growth, yield, quality and nutrient uptake by wheat (*Triticum aestivum* L.). Indian Journal of Agronomy. 1997;42(3):455-458.
28. Fisher RA, Yates F. Statistical Tables. Oliver and Boyd Edinburgh, London; c1963.
29. Ghulam A, Khan MQ, Muhammad J, Muhammad T, Fida Hussain. Nutrient uptake, growth and yield of wheat (*Triticum aestivum*) as affected by zinc application rates. International Journal of Agriculture and Biology. 2009;11(4):389-396.
30. Goswami NN, Rattan RK. Ecofriendly and efficient integrated nutrient management in sustainable agriculture. International conference on managing resources for sustainable agriculture production in 21st century, New Delhi, India; c2000. p. 41-47.
31. Gupta AK, Antil S, Singh M, Dixit ML. Nutrient management for high yield. Haryana Farming. 1994;6:7.
32. Hadis M, Meteke G, Haile W. Response of bread wheat to integrated application of vermicompost and NPK fertilizers. *African* Anonymous Agricultural Statistics at a Glance. Ministry of Agric., Govt. of India, New Delhi. Response of bread wheat to integrated application of vermicompost and NPK fertilizers. African Journal of Agricultural Research. 2018;13(1):14-20.
33. Han X, Xu C, Dungait JA, Bol R, Wang X, Wu W, Meng F. Straw incorporation increases crop yield and soil organic carbon sequestration but varies under different natural conditions and farming practices in China: A system analysis. Biogeosciences. 2018;15(7):1933-1946.

34. Han X, Xu C, Dungait JA, Bol R, Wang X, Wu W, *et al*. Straw incorporation increases crop yield and soil organic carbon sequestration but varies under different natural conditions and farming practices in China: A system analysis. Biogeosciences. 2018;15(7):1933-1946.
35. Hussain MI, Shah SH. Growth, yield and quality response of three wheat (*Triticum aestivum* L.) varieties to different levels of N, P and K. International Journal of Agriculture and Biology. 2002;4(3):362-364.
36. Itnal CJ. Organic in sustaining fertility and productivity. The University of Agricultural Science, Dharwad; c1998. p. 5-12.
37. Jackson ML. Soil chemical analysis. Prentice Hall of Indian Pvt. Ltd., New Delhi; c1967.
38. Jadhav AD, Talashikar SC, Power AG. Influence of conjunctive use of FYM, vermicompost and urea on growth and nutrient uptake in rice. Journal of Maharashtra Agricultural University. 1997;22(2):249-250.
39. Jain NK, Dahama AK. Effect of phosphorus and zinc on yield, nutrient uptake and quality of wheat (*Triticum aestivum*). Indian Journal of Agricultural Sciences. 2007;77(5):310-313.
40. Jain NK, Dahama AK. Effect of phosphorus and zinc on yield, nutrient uptake and quality of wheat (*Triticum aestivum*). Indian Journal of Agricultural Sciences. 2007;77:310-313.
41. Jana PK, Ghatak R, Sunda G, Ghosh RK, Badyopaddyay P. Effect of zinc fertilization on yield NPK and Zn uptake by transplanted rice at farmer’s field of red and laterite soils of West Bengal. Indian Agriculture. 2009;53(3-4):129-132.
42. Johnson CM, Ulrich A. Analytical methods for use in plant analysis. California Agricultural Experiment Station Bulletin, 1959, 766.
43. Karelia GN. Response of wheat to P and Zn fertilization and their residual effect on Bajra and Jawar fodder and their availability in the soil. Ph.D. Thesis, Gujarat Agricultural University Krushi Nagar, Gujrat; c1990.
44. Kathuria MK. Integrated nutrient management in cereal-fodder wheat cropping system. Ph.D. Thesis CCS Agricultural University, Hisar; c1997.
45. Kewat ML, Agrawal SB, Agrawal KK, Sharma RS. Effect of divergent plant spacing and age of seedlings on yield and economics of hybrid rice. Indian Journal of Agronomy. 2002;47(3):367-371.
46. Khanam R, Sahu, Mitra GN. Yield maximum of rice through integrated nutrient management on acric ustochrept. Journal of the Indian Society of Soil Science. 1997;45(2):367-397.
47. Khurana MDS, Nayyar VK, Singh SP. Direct and residual effect of applied zinc in cotton and wheat crops. Journal of the Indian Society of Soil Science. 1996;44(1):174-176.
48. Kumar A, Kushwaha KK, Singh S, Shivay YS, Meena MC, Nain L. Effect of paddy straw burning on soil microbial dynamics in sandy loam soil of Indo-Gangetic plains. Environmental Technology and Innovation. 2019;16:1-100469.
49. Kumar M, Babel AL. Available micronutrient status and their relationship with soil properties of Jhunjhunu tehsil, Jhunjhunu, Rajasthan, India. Indian Journal of Agricultural Sciences. 2011;3(2):97-106.
50. Kumar R, Kumar R, Shivani, Kumar S. Effect of N & K levels on growth of yield of hybrid rice. Journal of applied Biology. 2005;15(1):31-34.
51. Kumari K, Prasad J, Solanki IS, Chaudhary R. Long-term effect of crop residues incorporation on yield and soil physical properties under rice-wheat cropping system in calcareous soil. Journal of Soil Science and Plant Nutrition. 2018;18(1):27-40.
52. Kumawat PD. Response of barley to organic manure and nitrogen fertilization, Ph.D. Thesis. Rajasthan Agricultural University, Bikaner; c2003.
53. Laddha KC, Totawat KL. Interactive effect of tillage and phosphorus fertilizer in conjunction with FYM to sorghum + green gram intercropping system on performance of crops. Annals of Arid Zone. 1990;37:373-24.
54. Lavania PG, Manickram TS. Organic manure and their interactions with inorganic fertilizers on nutrient availability, uptake and yield of rabi crop. Madras Agriculture Journal. 1991;78(58):248-253.
55. Li J, Wen Y, Li X, Li Y, Yang X, Lin Z, *et al*. Soil labile organic carbon fractions and soil organic carbon stocks as affected by long-term organic and mineral fertilization regimes in the North China Plain. Soil and Tillage Research. 2018;175:281-290.
56. Lindsay WL, Norvell WA. Development of DTPA soil test for Zn, Fe, Mn and Cu. Soil Science Society of American Journal. 1978;42(3):421-428.
57. Maheswarppa HP, Nanjappa HV, Hegde MR. Influence of organic manure on yield of arrowroot, soil physico-chemical and biological properties when grown as intercrop in coconut garden. Annals of Agriculture Research. 1999;20:318-323.
58. Malik BS, Paui S, Ahilawat AK, Singh AM, Shivay YS. Productivity and quality of wheat spp. grown with different fertilization condition. Indian Journal of Agricultural Sciences. 2009;79(8):636-640.
59. Mandal KG, Misra AK, Hati KM, Bandyopadhyay KK, Ghosh PK, Mohanty M. Rice residue-management options and effects on soil properties and crop productivity. Journal of Food Agriculture and Environment. 2004;2(1):224-231.
60. Manna MC, Jha P, Lakaria B, Subba Rao A. Soil organic matter under different agro-climatic regions of India. Scientific Bulletin. Indian Institute of Soil Science, Bhopal; c2013. p. 1-87.
61. Metson AJ. Methods of chemical analysis for soil survey samples. Bulletin No. 2, Department of Science, Method Research Soil Bulletin; c1956.
62. Miller’s National Federation. From Wheat to Flour. The Federation, Washington, DC. WASDE. World Agricultural Supply and Demand; c2012
63. Mishra Mamta, Sahu RK, Sahu SK, Sahu RN. Growth, yield and elements content of wheat (*Triticum aestivum*) grown in composted municipal solid wastes amended soil. Environment, Development and Sustainability. 2009;11:115-126.
64. Modgal SC, Singh Y, Gupta PC. Nutrient management in wheat cropping system. Fertilizer. News. 1995;40(4):49-54.
65. Mohan B, Kumar P, Yadav RA. Effect of integrated nutrient management on yield attributes and yield of wheat (*Triticum aestivum* L.). Journal of Pharmacognosy and Phytochemistry. 2018;7(1):1545-1547.
66. Naga SR. Response of wheat to zinc and iron fertilization under irrigation with different RSC water. Ph.D. Thesis, Rajasthan Agricultural University, Bikaner; c2005.
67. Naphade KT, Deshmukh VN, Rawatkar SS, Solanki BU. Grain and nutrient uptake was irrigated wheat grown under various nutrient levels. Journal of the Indian Society of Soil Science. 1993;41(2):370-371.

68. Olsen SR, Cole RV, Watanabe FS, Lean LA. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. United States Department of Agriculture Circular-939; c1954.
69. Pandey IB, Dwivedi DK, Pandey RK. Integrated nutrient management for sustaining wheat (*Triticum aestivum*) production under late sown condition. Indian Journal of Agronomy. 2009;54(3):306-309.
70. Parihar NS. Effect of sulphur, zinc and organic manures on yield and nutrient uptake of wheat. Ph.D. Thesis, Rajasthan Agricultural University, Bikaner; c2002.
71. Pariyani AK, Naik KR. Effect of nitrogen levels and seedling number on attributes and yield of hybrids. Journal of Soils on Crops. 2004;14(2):234-236.
72. Patel KB, Kaswala AR, Dubey PK, Patel KG. Effects of in-situ decomposition of paddy straw residues and different organic manures on yield and soil health of onion under organic farming. Research in Environmental and Life Sciences. 2016;9:1232-1235.
73. Patel NM, Sadaria SG, Kaneria BB, Khanpara AD. Effect of N, K and Zn on growth and yield of wheat. Indian Journal of Agronomy. 1995;40:290-292.
74. Patra PS., Biswas S. Integrated nutrient management on growth yield and economics of maize (*Zea mays* L.) under terai region. Journal of Crop and Weed. 2009;5(1):136-139.
75. Phalke DH, Patil SR, Manna MC, Mandal ASIT, Pharande AL. Effect of in-situ recycling of sugarcane crop residues and its industrial wastes on different soil carbon pools under soybean (*Glycine max*) and maize (*Zea mays*) system. Indian Journal of Agricultural Sciences. 2017;87(4):444-454.
76. Pillai PS, Geethakumari VL. ISSAC SR. 2007. Balance-sheet of soil nitrogen in rice (*Oryza sativa*)-based cropping systems under integrated nutrient management. Indian Journal of Agronomy. 2017;52(1):16-20.
77. Piper CS. Soil and plant Analysis. The University of Adelaide, Australia; c1950. p. 59-74.
78. Rajput SC. Effect of integrated nutrient management on productivity and monetary returns of pearl millet (*Pennisetum glaucum*). Research on Crop. 2008;9:248-250.
79. Ram Lal, Singh Baldev, Singh Banani, Masih MR. Efficient recycling of mustard straw through vermicomposting for sustainable production of barley in semi-arid eastern plain zone of Rajasthan. Asian Journal of Soil Science. 2008;3(2):249-251.
80. Ranwa RS, Singh KP. Effect of integrated nutrient management with vermicompost on productivity of wheat (*Triticum aestivum* L.). Indian Journal of Agronomy. 1999;44(3):554-559.
81. Rezacnejad Y, Afyuni M. Effect of organic matter on soil chemical properties and corn yield and elemental uptake. Journal of Science and Technology Agriculture and Natural Research. 2001;4(4):19-29.
82. Richards LA. Diagnosis and improvement of saline-alkali soils, USDA Hand book No. 60, U.S. Department of Agriculture Washington D.C. (USA); c1954.
83. Sahu SK, Mitra GM, Pani SC. Effect of zinc application on uptake of nutrients by rice on an inceptisol. Journal of the Indian Society of Soil Science. 1996;44(4):795-916.
84. Selvi D, Santhy P, Dhakshinamoorthy M. Effect of inorganic alone and in combination with farm yard manure on physical properties and productivity of vertic haplusteps under long term fertilization. Journal of Indian Society of Soil Science. 2005;53(3):302-307.
85. Sharma BL, Bapat PN. Levels of micronutrients cations on various plants parts of wheat as influenced by Zn and phosphorus application. Journal of the Indian Society of Soil Science. 2000;48:130-134.
86. Shatilov LS, Sharov AF. Productivity of field crops and indications of soil fertilizers. Izvestiya Timiryazerskoi jel Sko khozyaistvennoi Akademii, 3-11 (F.C.A.). 1992;45:74-38.
87. Shivay YS, Singh S. Effect of planting geometry and nitrogen levels on growth, yield and nitrogen use efficiency of scented hybrid rice. Indian Journal of Agronomy. 2003;48(1):42-44.
88. Shreeniwas C, Muralidhar S, Rao MS. Yield and quality of ridge guard fruits as influenced by different levels of inorganic fertilizers and vermicompost. Annals of Agriculture Research. 2000;21(2):162-166.
89. Shwetha BN, Babalad HB, Patil RK. Effect of combined use of organics in soybean-wheat cropping system. Journal of Soils and Crops. 2009;19(1):8-13.
90. Singh DV, Tripathi BR. Effect of N, P, K, Fertilization on the uptake of indigenous and applied zinc by wheat (S-207). Journal of the Indian Society of Soil Science. 1974;22:244-248.
91. Singh H, Singh AK, Alam S, Singh T, Singh VP, Parihar AKS, *et al*. Effect of Various Integrated Nutrient Management Models on Growth and Yield of Wheat in Partially Reclaimed Sodic Soil. International Journal of Current Microbiology and Applied Sciences. 2017;6(3):803-808.
92. Singh KK, Singh K, Singh CS, Singh R. Nitrogen nutrition in rice-a review. Crop Research. 2005;29(2):330-336.
93. Singh LN, Singh RKK, Singh AH, Chhangate Z. Efficacy of urea in integration with *Azolla* and vermicompost in rainfed rice (*Oryza sativa*) production and their residual effect on soil properties. Indian Journal of Agricultural Sciences. 2005;75(1):44-45.
94. Singh RA. Soils physical Analysis. Kalyani Publisher, Ludhiana; c1980. p. 163.
95. Singh RI. Effect of phosphorus, zinc and mixtalol on growth and yield of wheat (*Triticum aestivum* L.). M.Sc. (Ag.) Thesis Rajasthan Agricultural University, Bikaner; c1996.
96. Singh RK, Sharma GK, Kumar P, Singh SK, Singh R. Effect of crop residues management on soil properties and crop productivity of rice-wheat system in inceptisols of Seemanchal region of Bihar. Current Journal of Applied Science and Technology; c2019. p. 1-6.
97. Singh S, Varma SC, Singh RP. Effect of integrated nutrient management on yield, nutrient uptake and changes in soil fertility under rice-wheat cropping system. Indian Journal of Agronomy. 2001;46(2):191-197.
98. Snell FB, Snell CT. Colorimetric methods of analysis. II AD Vannostrond Co. Inc. New York; c1949.
99. Somani LL, Saxena SN. A study on the decomposition of some organic matter sources in the medium black soil of Udaipur-humus build up and nutrient availably. Udaipur University Research Journal. 1977;15:3-41.
100. Subbiah BV, Asija GL. A rapid procedure for the estimation of available nitrogen in soils. Current Science. 1956;25(8):259-260.
101. Swami S, Shekhawat K. Influence of zinc under different moisture regimes on yield and nutrient uptake of rice in inceptsol. Agricultural Science Digest. 2009;29(2):114-116.
102. Thomas, Abraham, Lal RB. Effect of integrated nutrient

management on productivity of wheat (*Triticum aestivum* L.) and soil fertility in a legume based cropping system. Indian Journal of Agriculture Research. 2004;38(3):178-183.
103. Tolanur SL, Badnur VP. Changes in organic carbon, available N, P and K under integrated use of organic manure, green manure and fertilizer on sustainable productivity of pearlmillet-pigeonpea system and fertility of an inceptisol. Journal of the Indian Society of Soil Science. 2003;51(1):37-41.
104. Vardana SS, Pahuja SK, Thakral L, Kumar A. Nutrient content and their uptake in hybrid pearlmillet as affected by organic and inorganic fertilizers. Haryana Journal of Agronomy. 2008;24(1-2):88-89.
105. Varshney P, Singh SK, Srivastva PC. Frequency and rates of zinc application under hybrids rice-wheat sequence in a molisol of Uttarakhand. Journal of the Indian Society of Soil Science. 2008;56(1):92-98.
106. Vasanthi D, Kumaraswamy K. Efficacy of vermicompost to improve soil fertility and rice yield. Journal of the Indian Society of Soil Science. 1999;47(2):268-272.
107. Venkatesh MS, Hazra KK, Ghosh PK, Praharaj CS, Kumar N. Long term effect of pulses and nutrient management on soil carbon sequestration in Indo-Gangetic plains of India. Canadian Journal of Soil Science. 2013;93(1):127-136.
108. Wei T, Zhang P, Wang K, Ding R, Yang B, Nie J, *et al*. Effects of wheat straw incorporation on the availability of soil nutrients and enzyme activities in semiarid areas. PLoS One. 2015;10(4):e012-0994.
109. Yadav DS, Kumar A. Long-term effect of nutrient management on soil health and productivity of rice (*Oryza sativa*)-wheat (*Triticum aestivum*) system. Indian Journal of Agronomy. 2009;54(1):15-23.
110. Yadav SR. Inter-relationship among nitrogen, phosphorus pyrite and organic materials and its effect on yield and nutrition of mustard in loamy sand. Ph.D. Thesis, RAU, Bikaner; c1999.
111. Zende GK, Ruikar SK, Rvikar SK, Joshi SN. Effect of application of vermicompost along with chemical fertilization on sugarcane yield and quality. Indian Sugar. 1998;48(5):357-369.
112. Zhao Yunchen, Wang Ping, Ligianlong Chen Yuru, Ying Xianzhi, Liu Shuying. The effects of two organic manures on soil properties and crop yields on a temperate calcareous soil under a wheat-maize cropping system. European Journal of Agronomy. 2009;31(1):36-42.
113. Mann SS, Singh RN. Studies on Cold Storage of Mango Fruits (*Mangifera ndica* L. Cv. Langra). Indian Journal of Horticulture. 1975;32(1-2):7-14.
114. Gupta MA, Gupta AK. Depression and suicidal ideation in dermatology patients with acne, alopecia areata, atopic dermatitis and psoriasis. British Journal of Dermatology. 1998;139(5):846-850.
115. Kumar S. Theories of musculoskeletal injury causation. Ergonomics. 2001;44(1):17-47.
116. Yoshida R, Imanishi J, Oku T, Kishida T, Hayaishi O. Induction of pulmonary indoleamine 2, 3-dioxygenase by interferon. Proceedings of the National Academy of Sciences. 1981;78(1):129-132.
117. Nayak SK, Murty KS. Effect of varying light intensities on yield and growth parameters in rice. Indian Journal of Plant Physiology. 1980;23(3):309-16.
118. Venkateswarlu B, Vergara BS, Visperas RM. Influence of Photosynthetically Active Radiation on Grain Density of Rice 1. Crop science. 1987;27(6):1210-1214.